

Unit 2 Radiological Transportation Accidents

In this unit you will learn:

- ☞ Types of radioactive material shipments and associated packaging.
- ☞ Information sources available at the scene of a radioactive material accident that describe the nature of the potential hazard.
- ☞ On-scene accident response actions for the general public.

INTRODUCTION

Millions of packages of radioactive materials are transported in the United States annually. Most shipments consist of medical and industrial products. Other shipments include nuclear power plant fuel, nuclear weapons and weapons material, and radioactive waste generated by hospitals, laboratories, nuclear reactors, and military facilities.

Because of the sheer number of radioactive material shipments, transportation accidents are the most common type of incident involving radioactive materials. Despite their frequency, there have been no known serious nuclear radiation exposures resulting from transportation accidents. This is due largely to the nature of the radioactive materials transported and the use of protective packaging commensurate with the degree of potential hazard of the radioactive material contained.

This unit is divided into three major sections: Packaging, Information Sources, and On-scene Accident Response. Each of these sections contains information that can be used to understand and respond to transportation accidents involving radioactive materials.

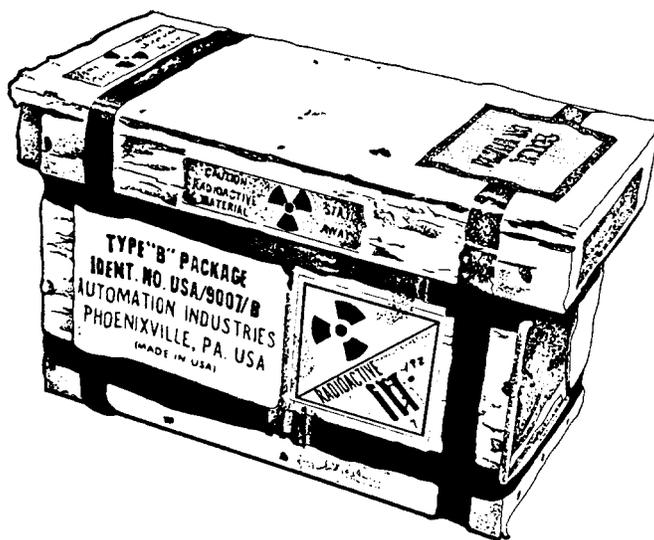
The **Packaging** section describes the various degrees of protective packaging used for the various types of radioactive material shipments.

The **Information Sources** section describes sources of information available to a member of the public at an accident scene that describe the hazards which may be present. These sources may include package labels, package markings, vehicle placards, and shipping papers.

The **On-scene Accident Response** section describes actions which should be taken by a member of the public at the scene of a transportation accident involving radioactive materials. These actions include helping injured individuals, notifying the authorities, and isolating the area.

PACKAGING

As we have mentioned, there have been no known serious radiation exposures resulting from transportation accidents in the United States despite the millions of shipments made each year. This excellent safety record is due to the close attention given by the shippers to the proper packaging of radioactive materials.



Radioactive Material Package

The types of radioactive material packages addressed in this section, listed in order of increasing potential hazard and therefore, of increasing package integrity, are as follows:

- ☞ Industrial packaging.
- ☞ Type A packaging.
- ☞ Type B packaging.

Industrial Packaging

Industrial packaging is used for shipping low, specific activity, materials and surface contaminated objects. Low specific activity (LSA) materials are generally materials in which radioactivity is essentially uniformly distributed in a large amount of nonradioactive material. Surface Contaminated Objects (SCO) are nonradioactive items with surfaces slightly contaminated with radioactive materials. LSA materials include uranium ore concentrate, low-level waste from hospitals, laboratories and power plants such as contaminated protective clothing and trash and building rubble from cleanup projects. SCO include pieces of equipment used in nuclear power plants that are very slightly contaminated on the surface.

When LSA and SCO materials are transported with other commodities by common carrier, they must be marked, labeled, and contained in industrial packages that meet basic and industrial packaging requirements (as described above). Industrial packaging will be designated as either IP-1, IP-2, or IP-3

depending upon its design and ability to contain the materials inside. However, when they are transported with certain special arrangements between the shipper, carrier and receiver for controlling transport conditions, the packaging need only be "strong tight packages" that will not allow loss of contents under normal transport conditions. These "strong tight packages" will not display the usual required marking and labeling. Instead, they will be marked "RADIOACTIVE-LSA" or "RADIOACTIVE-SCO."

Because the radioactivity in a LSA or SCO shipment is very dilute, the potential radiation hazard is very low. If LSA or SCO packages were involved in an accident, large volumes of low level radioactivity could be dispersed but the risks to public health would be minimal.

Type A Packaging

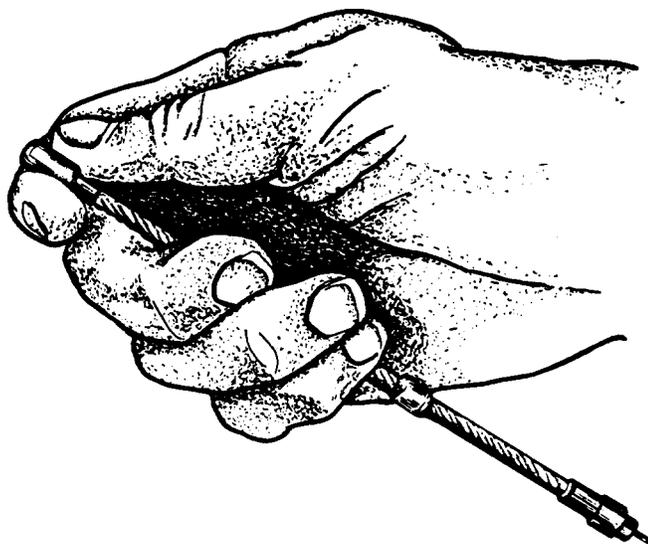
The majority of radioactive material shipments are made with Type A packaging. Examples of materials shipped in Type A packaging include training sources, radiopharmaceuticals, and research and industrial sources.

The amount of radioactivity allowed in a Type A package is greater than that allowed in limited quantity packages but lower than that of Type B packages (described below). Thus, accidents that may cause damage to Type A packaging would not likely result in serious radiation hazards.

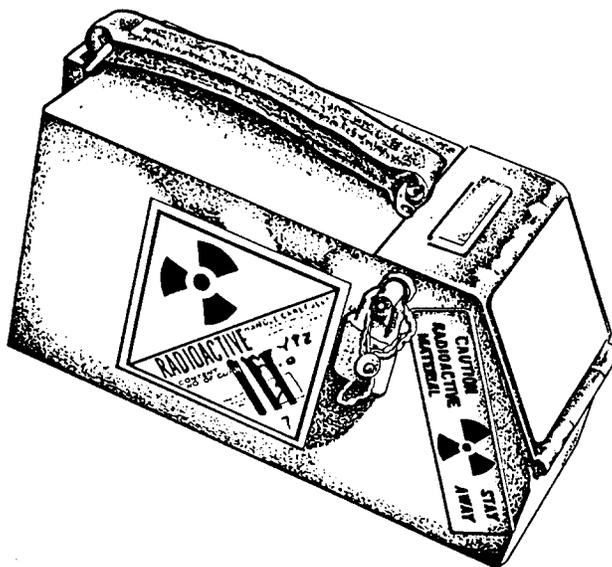
Generally, Type A packaging is designed to withstand the stress of transit under **nonaccident** conditions (including rough handling) and must be labeled as "radioactive." Even though Type A packaging is not designed to prevent the loss of the contents under accident conditions, there have been many accidents involving Type A packaging in which there was no loss. In those accidents where there was loss of contents, no adverse health or environmental effects resulted due to the limited amount of radioactivity allowed in the packaging.

Type B Packaging

Certain shipments of more highly radioactive materials require Type B packaging. Examples of such materials include radiography sources, larger research and industrial sources, and spent nuclear reactor fuel. Most Type B shipments are made by commercial carriers, by tractor trailer or by rail. However, some such as radiography sources which are used to "X-ray" construction welds, may be transported from construction site to construction site in private vehicles. Touching an unshielded radiography source (as shown below) would be extremely hazardous. Such sources are normally carried in a heavily shielded container.



Radiography Source



Radiography Source Container

The amount of radioactivity allowed in a Type B package is greater than that allowed in a Type A package. Because certain Type B packages may contain amounts of radioactivity which could be harmful if released to the environment, Type B packages are strictly designed to contain their contents under **accident** as well as nonaccident conditions. In addition to meeting Type A packaging standards, Type B packaging must withstand severe puncture, drop, thermal and water immersion tests simulating transportation accident conditions. Although Type B packages have been involved in actual transportation accidents, no releases have occurred.

Limited Quantity Shipments

Many radioactive shipments involve quantities of radioactivity and levels of surface radiation exposure that are extremely low. Such shipments (called limited quantity shipments) may be shipped in regular packaging materials.

Typical radioactive materials shipped in limited quantities include certain medical diagnostic kits, research and industrial test materials, and radioactive devices such as smoke detectors, luminous watch dials, and special electronic instruments. Such materials are shipped routinely by common carriers. The U.S. Postal Service also transports such packages although the amount of radioactivity allowed per package is one-tenth that permitted for transport by other carriers.

The potential radiation hazard from a limited quantity shipment is very low. However, if packages involved in such shipments were destroyed in an accident, measurable amounts of radioactivity might be found in the debris.

In summary, packaging requirements reflect the degree of hazard associated with the type, quantity and other characteristics of the radioactive materials shipped. Most shipments present minimal potential hazard, even if there is some release. For shipments with significant potential hazards (Type B), the packaging is designed to prevent the release of the contents. To date, no releases have occurred from Type B packages under accident conditions.

Practice Exercise

11. The type of packaging designed to prevent all leakage after a transportation accident is _____ packaging.
12. Items such as smoke detectors and luminous watch dials containing extremely low levels of radioactive materials may be shipped in unlabeled _____ packaging.
13. Packages designed to prevent leakage during normal (nonaccident) transportation conditions are _____ packages.

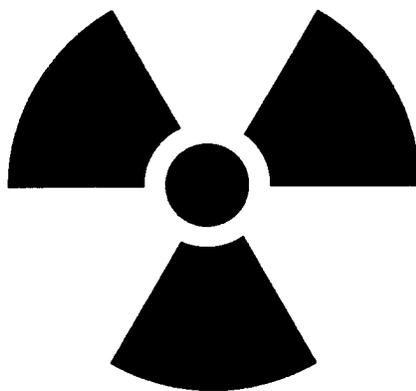
INFORMATION SOURCES

As we have learned, transportation accidents involving radioactive materials have never resulted in significant radiation exposures due largely to the packaging required. To verify that an accident presents a minimal hazard, however, one must determine certain information about the radioactive material involved. Information sources available at an accident scene before the arrival of trained radiation monitoring personnel include:

- ☞ Package labels.
- ☞ Package marking.
- ☞ Vehicle placards.
- ☞ Shipping papers.

Package Labels

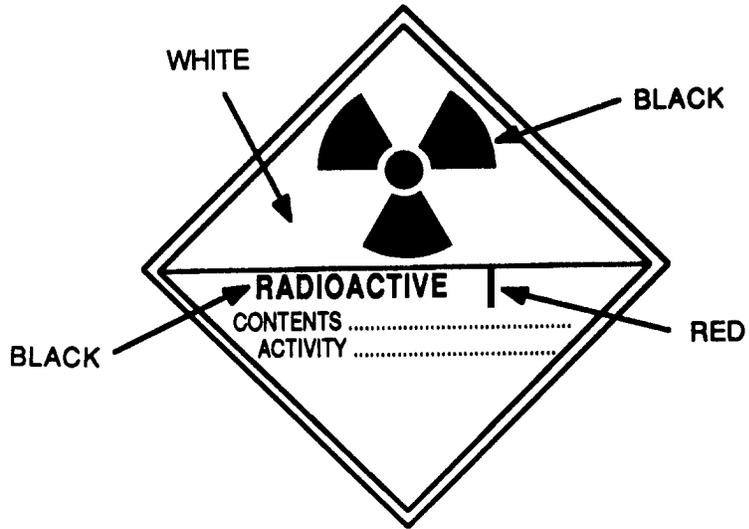
Nearly all packages containing radioactive materials are required to be labeled "RADIOACTIVE." The exception to this requirement, as has been mentioned, is limited quantity packages. These exempted quantities have very little radioactivity associated with them and would present a minimal hazard in the event of an accident.



Tri-blade Radiation Symbol

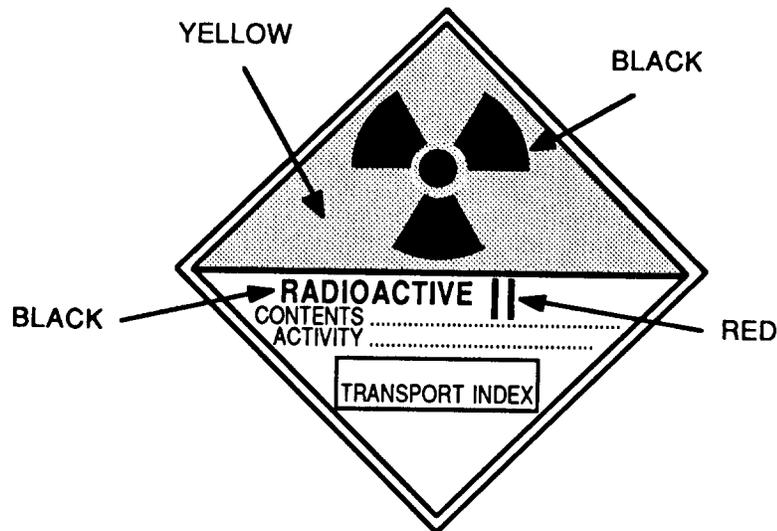
There are three basic labels which are used to identify radioactive materials. All of the labels bear the distinctive tri-blade symbol which is universal for the identification of radioactivity or radiation. By looking at a package's label, one can determine the hazards associated with it without the aid of a radiation monitoring device.

The radioactive White-I label is used on packages with a maximum dose rate of .005 mSv/hr (0.5 mR/hr) on any exterior surface. This measurement is taken "on contact" with the package.

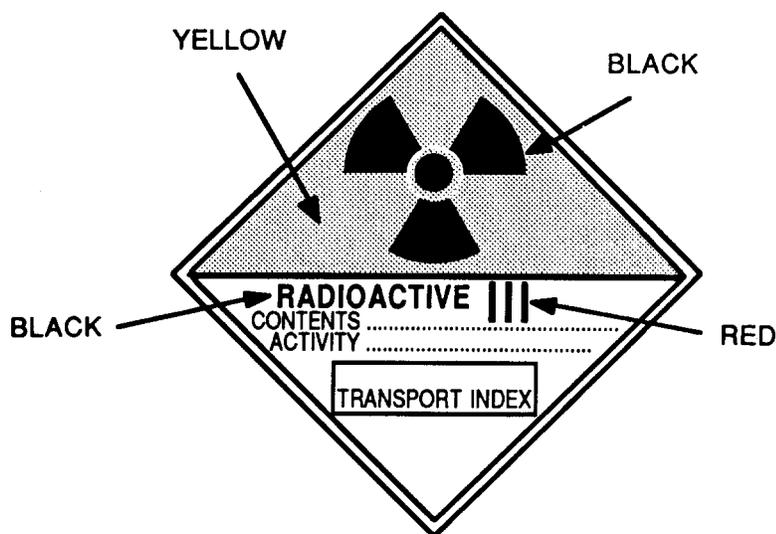


Radioactive White-I Label

The Radioactive Yellow-II label is used on packages which have a maximum dose rate of .5 mSv/hr (50 mR/hr) on any exterior surface. The Radioactive Yellow-III label is used on packages with a maximum dose rate of 2 mSv/hr (200 mRr/hr) on their exterior surfaces.



Radioactive Yellow-II Label



Radioactive Yellow-III Label

The labels are white except for the upper half of the Radioactive Yellow-II and Radioactive Yellow III labels which are yellow. The printing and the radiation symbol are black except for the "I," "II," or "III" numerals which must be red. The type of label quickly indicates to any informed member of the public or to responders the radiation exposure rate near the package (if the package has not broken open). If the package is broken, the hazard **might** be greater due to the loss of shielding provided by the packaging material or due to the possibility of a contamination hazard.

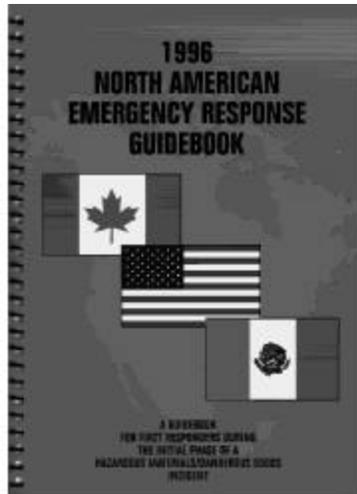
Radioactive package labels also list the type of radioactive nuclide contained and the amount of activity. This additional information is valuable to radiation protection specialists in determining the degree of hazard present if a package breaks releasing radioactive material.

An "exclusive use shipment" can be used to ship a package with a maximum dose rate of 10 mSv/hr (1,000 mR/hr) if special requirements and instructions are followed. Note that in all cases, the radiation exposure rate at the surface of an unbroken package should be no more than 1,000 mR/hr.

Package Marking

Generally, every package labeled as radioactive will also have a marking showing a certain "proper shipping name" and a four digit "U. N. Identification Number." For example, the marking on package might show the words "Radioactive Material, Low Specific Activity" (LSA) and the number "U.N. 2912." With either the proper shipping name or the identification number, emergency responders can determine the proper response actions to be taken.

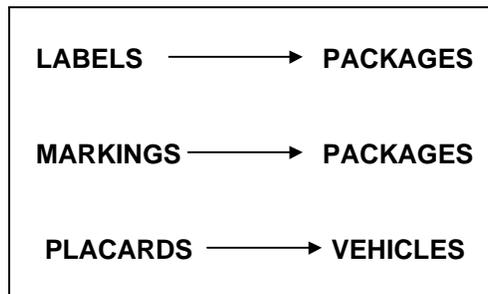
Actions keyed by a given proper shipping name or U.N. identification number include fire fighting strategies, spill or leak confinement techniques, and first aid considerations. These actions are published in the U.S. Department of Transportation's Emergency Response Guidebook which is used by fire, law enforcement, and other emergency response organizations for dealing with all kinds of hazardous material emergencies.



DOT Emergency Response Guidebook

Vehicle Placards

Just as labels and markings are used to show the quantity of radioactivity in a **package**, and to generally indicate the level of radiation emitted, placards are standard signs affixed to the exterior of a **vehicle** or freight container to identify hazards associated with the cargo.



Labels and Placards

Any vehicle carrying a package with a Radioactive Yellow-III label is required to bear the placard shown below. Certain other vehicles, such as those carrying "strong tight" LSA packages, must also be placarded. The RADIOACTIVE placard must be yellow on the top half with the black tri-blade symbol. The bottom half must be white with the word RADIOACTIVE inscribed in black. Vehicle placards can help a great deal following an accident, particularly for a closed vehicle where the packages have remained in the vehicle.



Placard

Highway vehicles transporting larger specified quantities of radioactive materials are required to have the previously described placard placed on a white square as shown below.



Placard On White Square

Placards are used by shippers so that emergency response personnel can determine the appropriate actions to be taken when first arriving at an accident scene. Emergency response actions such as fire fighting strategies, spill or leak confinement techniques, and first aid considerations are keyed by a given hazardous material placard just as they are by the proper shipping name and U.N. identification number found on the package marking.

Shipping Papers

A fourth source of information about a radioactive material shipment available at the scene of a transportation accident is shipping papers. With certain exceptions, shipping papers identifying hazardous materials are required to be kept in:

- ☞ The cab of a motor vehicle within easy access to the driver.
- ☞ The possession of a train crew member.
- ☞ A holder on the bridge of a sailing vessel.
- ☞ An aircraft pilot's possession.

One (1) Box, Thorium Nitrate, Radioactive Material, UN 2976, 15 kg, ThNatural, Solid (Powder), 1.3 mCi, Radioactive White - 1 and Oxidizer Labels, Cargo Aircraft Only

Sample Shipping Paper Entry

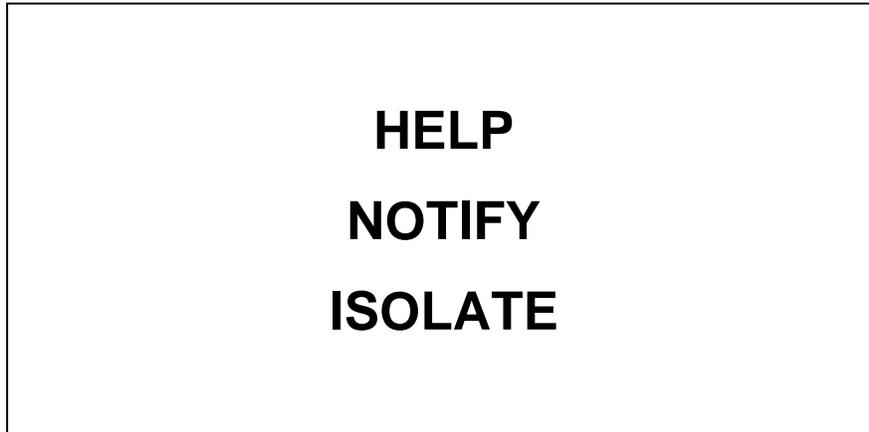
Shipping papers list all of the information provided by the package labels and markings. They also provide additional information including the physical and chemical form of the material, the material's hazard class (e.g., "Radioactive Material" or "Flammable Liquid"), and the material's identification number (e.g., "UN 2976" for radioactive thorium nitrate). The material's identification number is used by trained emergency response personnel to quickly determine the appropriate actions to be taken upon arrival at an accident scene.

Practice Exercise

14. The four sources of information about the contents of a radioactive material shipment are _____, _____, _____, and _____.
15. Package labels indicate the maximum amount of radiation present after the package has broken open in a transportation accident. (True or False)
16. The maximum exposure rate permitted at the surface of a radioactive material package during shipping is _____.

ON-SCENE ACCIDENT RESPONSE

Actions which should be taken before the arrival of trained emergency response personnel are **helping** injured personnel, **notifying** the appropriate authorities, and **isolating** the area.



Help, Notify, and Isolate

Help Injured Individuals

As we have learned, the likelihood that nuclear radiation levels at an accident scene would be high enough to cause injury to a responder is extremely remote. Unbroken radioactive material packages never have a surface radiation level exceeding 1000 mR/hr, and packages likely to break under accident conditions are used only for materials low enough in radioactivity to present no immediate hazard if dispersed. Therefore, help for injured individuals should not be delayed out of concern for radiological hazards. The responder should give normal first aid to the extent qualified.

Notify the Authorities

Using any form of communication available, an individual responding to an accident should notify the authorities of the accident. The local 9-1-1 emergency service or the local police or fire departments should be able to respond properly.

It is important to give the greatest amount of detail possible when calling for help. Important information includes:

- ☞ The location and nature of the accident.
- ☞ The cargo (if easily identified by vehicle placards or package labels).
- ☞ Your name and the phone number from where you are calling (if applicable).

- ☞ The number of persons injured and the seriousness of their injuries.
- ☞ The actions being taken at the time of the call.

If at all possible, communications should be maintained until the authorities have arrived. It is important for those first on the scene to wait for the arrival of authorities and give them a full description of the events that occurred before their arrival. This will ensure that all persons involved understand the potential hazards and that all personnel will receive proper medical treatment and be decontaminated as required.

Isolate the Area

Once injured individuals have been helped and the authorities have been notified, the accident scene should be isolated. Two reasons are:

- ☞ To prevent the spread of low-level radioactive contamination.
- ☞ To prevent exposure to high-levels of radiation in the highly unlikely event of a release of highly radioactive materials or a high level sealed source.

Radioactive materials released at an accident scene, even at levels of little consequence, can result in very small but still detectable levels of contamination being spread a great distance. The spread of contamination can be controlled by limiting access to and egress from the accident scene. Although, in some cases, the contamination spread would be of insignificant radiological consequence, any **detectable amount** can prove to be of great concern to the public and news media.

It is important to treat everything that has been near the accident as potentially radioactive and contaminated until it has been verified by qualified radiation protection personnel to be free of radioactive contamination. Individuals who have contacted potentially contaminated materials should remain on-hand until they have been checked by qualified personnel. **Only qualified personnel should attempt to clean up a spill of any hazardous materials--radioactive or not.**

Very severe accidents involving highly radioactive Type B shipments are highly improbable, but not impossible. Such an accident might require an extensive response **if the package were severely damaged and involved a release of a significant fraction of its contents.** Although this has never occurred and is highly unlikely because of the stringent packaging requirements, response plans should be implemented for such an accident, even if only to verify that there is no hazard.

If a radioactive materials package has been badly damaged or if you suspect that it is leaking, do not panic. The steps to take are simple:

- ☞ Stay away from the package and do not touch it.
- ☞ Keep other people away from the package.
- ☞ Tell anyone who may have touched the package to remain on-hand to be checked by radiation protection specialists.
- ☞ If you touched the package or objects near it, wash your hands with lukewarm water.

Practice Exercise

17. The three key actions to be taken before the arrival of trained emergency response personnel at the scene of an accident involving radioactive material are _____, _____, and _____.
18. Safe radiation levels should be verified before providing lifesaving first aid for accident victims. (true or false).
19. Cleanup of a hazardous material spill should be attempted only by _____.

UNIT 2 REVIEW

This unit described the hazards and protective measures associated with a radiological transportation accident. Transportation of radioactive material is highly regulated to minimize the risk of serious hazards in the event of an accident.

Radioactive materials are packaged, marked, labeled and placarded with public safety as the foremost goal. The degree of packaging used is commensurate with the degree of hazard of the contents. Extremely hazardous radioactive materials are shipped in packaging which does not break under accident conditions. Low-level radioactive materials are shipped in less resistant packages and may be dispersed. However, if dispersed, these materials would present only a minimal health risk and would be easily detectable by radiation protection specialists.

The three steps to be taken before the arrival of trained emergency response personnel at an accident scene are to help injured individuals, to notify the authorities, and to isolate the area. Help for injured individuals should not be delayed out of concern for radiological hazards.

UNIT 2 REVIEW QUESTIONS

Answer the following questions to review your knowledge of the Radiological Transportation Accidents unit. Read each question carefully and circle the correct answer.

1. In the United States serious radiation exposures:
 - a. Frequently result from radioactive transportation accidents due to the large number of such shipments
 - b. Have resulted from improper packaging of radioactive material shipments
 - c. Have resulted from improper labeling of radioactive material shipments
 - d. Have not resulted from radiological transportation accidents due largely to the nature of the materials transported and the use of appropriate protective packaging
2. Shipments of limited quantity radioactive materials such as smoke detectors and luminous watch dials require:
 - a. Normal industrial packaging
 - b. Type A packaging
 - c. Type B packaging
 - d. "Strong tight" packaging
3. Type B radioactive material packaging is designed and tested to withstand:
 - a. Normal handling conditions
 - b. Normal and rough handling conditions
 - c. Normal and rough handling, and accident conditions

4. Sources of information about radioactive material shipments which are posted on the exterior of shipment vehicles are:
 - a. Labels
 - b. Markings
 - c. Placards
 - d. Shipping papers
5. The Radioactive Yellow-I, Yellow-II, and Yellow-III package labels indicate:
 - a. The radiation exposure rate near the package if the package has broken open
 - b. The radiation exposure rate near the package if the package has not broken open
 - c. The U.N. identification number
 - d. The proper shipping name
6. The maximum radiation exposure rate at the surface of an unbroken radioactive material package may be at most:
 - a. .5 mSv/hr (50 mR/hr)
 - b. 2 mSv/hr (200 mR/hr)
 - c. 10 mSv/hr (1000 mR/hr)
 - d. 1 Sv/hr (100 R/hr)
7. A member of the public should give lifesaving first aid to injured victims of a radiological transportation accident:
 - a. Immediately after notifying the appropriate authorities
 - b. After isolating the area
 - c. After verifying that no radioactive material packages have been broken open
 - d. Without delay out of concern for radiological hazards (within the extent of their training)

8. The scene of a radiological transportation accident should be isolated to prevent:
 - a. The spread of radioactive contamination away from the accident site
 - b. Exposure to high levels of radiation in the unlikely event of a release of highly radioactive materials or a high level exposed source
 - c. Both A and B
 - d. Neither A nor B

UNIT 2 REVIEW ANSWER KEY

1. d
2. a
3. c
4. c
5. b
6. c
7. d
8. c